

09/423155

420 Rec'd PCT/PTO 02 NOV 1999

PCT/DE98/01186
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Claims

1. Imaging and/or raster-mode scanning apparatus, in particular scanning microscope, having a compensation device for compensating for ambient influences that may degrade the imaging, comprising:
5 - an image acquisition device (7) for acquiring at least one pixel of an object, and
- an image processing device (2) which is connected downstream of the image acquisition device, and also an image display device, furthermore at least
10 - an electrical filter (5),
- a sensor (4) for picking up a first signal, and
- an actuator and/or a control element (3),
15 characterized in that the first signal dependent on the ambient influences passes through the filter directly and drives an actuator and/or a control element (3) which has an effect on the imaging and/or on the image display, in
20 the calibrated state of the apparatus, which is characterized by the setting of the transfer characteristic of the filter, the image degradation is greatly reduced or essentially compensated for, and in that the filter (5), for calibrating the apparatus,
25 has a calibration input and a second signal is applied to the calibration input of the filter.
2. Apparatus according to Claim 1, characterized in that the apparatus comprises at least one sensor (4) for
30 detecting at least one physical quantity outside the apparatus, this sensor (4) outputting the first signal which depends on the ambient influences at the location of the sensor (4).
3. Apparatus according to Claim 2,
35 characterized in that

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the sensor (4) comprises at least one pick-up for electromagnetic and/or magnetic fields and/or air vibrations and/or ground vibrations.

4. Apparatus according to Claim 1,

5 characterized in that

the signal input of the filter (5) is connected to an output of the image processing device (2).

6. Apparatus according to ~~one of the preceding claims~~,
7 characterized in that

the apparatus comprises a device for the manual calibration of the filter.

8. Apparatus according to ~~one of the preceding claims~~,

9 characterized in that

the control element (3) is arranged in the image processing device (2) and at least part of the image degradation is reduced or compensated for in the image processing device.

10. Apparatus according to ~~one of the preceding claims~~,

11 characterized in that

the actuator (3) is assigned to a scanning device of the apparatus.

12. Apparatus according to ~~one of Claims 1 to 4, 6 or 7~~,

13 characterized in that

an output of the image processing device (2) is connected to the calibration input of the filter (5).

14. Apparatus according to ~~one of the preceding claims~~,

15 characterized in that

the second signal varies as a function of a scanning position of the scanning device and/or of time.

16. Apparatus according to ~~Claims 2 and 8~~,

17 characterized in that

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the apparatus is designed for operation in a calibration mode and for subsequent operation in an image mode,

whereby, in the calibration mode, ambient influences
5 which degrade the image are detected by the imaging of a predetermined reference object and comparison of the image with the real structure of the reference object in the image processing device, and are greatly reduced or essentially compensated for by calibration of the
10 filter, and

whereby the image defects are compensated for by maintaining the calibration in the image mode, even in the event of a change in the ambient influences.

11. Apparatus according to Claim 10,
15 characterized in that in the calibration mode:

- a scanning device scans a selected section of a reference object,

- the digital image processing device (2) compares a stored signal assigned to the reference object with the image signal of the reference object, the said image signal having been obtained from the image acquisition device (7), and forms a defect signal assigned to the difference and outputs it to the filter (5), and

20 25 - the apparatus stores, in a memory, data for generating the second signal for setting the transfer parameters of the filter for the image mode.

12. Apparatus according to Claim 10,
30 characterized in that in the image mode:

- a scanning device scans the object to be imaged, and

- the apparatus, taking the data stored during the calibration mode as the basis, generates the second signal for defining the transfer parameters of the filter.

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- 9 13. Apparatus according to ~~Claims 2 and 8,~~ ^{Cla, m 2} characterized in that the apparatus is set up for automatically calibrating the filter during the image mode.
- 5 14. Apparatus according to Claim 13, characterized in that the image acquisition device (7) scans the object to be imaged and the image processing device (2) is set up for determining a temporal displacement of line
- 10 centroids of successive image lines within the whole image and outputs the second signal as a function of this temporal displacement to the filter (5).
15. Apparatus according to Claim 13, characterized in that
- 15 15 the image processing device is set up for determining the temporal displacement of an image centroid of successive images and outputs the second signal as a function of this temporal displacement to the filter (2).
- 9 20 16. Apparatus according to ~~one of Claims 13 to 15,~~ ^{Cla, m 13} characterized in that the filter is set up for carrying out the cross-correlation of the first signal and of the second signal.
- 9 25 17. Apparatus according to ~~one of the preceding~~ ^{Cla, m 1} claims, characterized in that the apparatus is set up for reducing or compensating for the image degradation by means of actuators and/or
- 30 control elements acting in two mutually orthogonal directions.
- 9 18. Apparatus according to ~~one of the preceding~~ ^{Cla, m 1} claims, characterized in that
- 35 18 the apparatus comprises a scanning electron microscope, a force microscope, a surface roughness measuring

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- instrument, an optical scanning microscope, a light microscope, a transmission electron microscope or a lithography installation.
19. Apparatus according to Claim 18,
5 characterized in that,
in the case of the electron microscope, the actuator (3) comprises a device for deflecting the electron beam and/or a device for displacing the sample.
20. Apparatus according to Claim 18,
10 characterized in that,
in the case of the light microscope, the actuator (3) comprises a device for deflecting the light and/or a device for displacing the sample. (Claim 4)
21. Apparatus according to Claims 4, 8 and 15,
15 characterized in that
the apparatus is a light microscope or a transmission electron microscope, the first signal also being determined from the temporal displacement that is determined.
22. Method for operating an imaging and/or raster-mode scanning apparatus for compensating for ambient influences that may degrade the imaging, in particular for operating an apparatus according to one of the preceding claims 1 to 21,
- a
25 a first signal dependent on the ambient influences being passed directly through an electrical filter (5) and the output signal of the filter driving an actuator and/or a control element (3) which has an effect on the imaging and/or the image display, whereby, in the calibrated state of the apparatus, which is effected by setting a transfer characteristic of the filter, given by transfer parameters, the image degradation is greatly reduced or essentially compensated for, and the calibration of the apparatus is carried out by the
30 setting of the filter (5) by a second signal being applied to the calibration input of the filter.
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23. Method according to Claim 22,
characterized in that
the calibration of the apparatus is carried out by
manual setting of the filter (5).
- 5 24. Method according to Claim 22,
characterized in that
a control element (3) in the image processing device
(2) is driven and the compensation of the image
degradation is carried out at least partially in the
10 image processing device.
25. Method according to Claim 22,
characterized in that
an actuator (3) in the scanning apparatus is driven and
the compensation of the image degradation is carried
15 out at least partially by driving the actuator (3) of
the scanning apparatus.
26. Method according to Claim 22,
characterized in that
the apparatus is operated in a calibration mode and
20 subsequently in an image mode, whereby
- ambient influences that degrade the imaging are detected by means of a sensor (4) which is arranged outside the apparatus and drives the signal input of a filter (5),
 - in the calibration mode, the degradation of the image is greatly reduced or essentially compensated for by the imaging of a predetermined reference object and comparison of the image with the real structure of the reference object and by calibration of the transfer characteristic of the filter, and
 - in the image mode, the degradation of the image is at least partially compensated for by maintaining the calibration, even in the event of a change in the ambient influences.
- 35 27. Method according to Claim 26,

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characterized in that

the calibration mode comprises at least the following steps:

- determination of a first signal which depends on the interfering influence at the location of the sensor, by a sensor (5) arranged outside the apparatus;
- application of the first signal to the signal input of the filter;
- acquisition of a selected section (9) of a predetermined reference object by means of an image acquisition device (7) by the scanning of the reference object;
- comparison of the acquired image with the real structure of the reference object; and
- determination of a defect signal assigned to the difference;
- application of the second signal, derived from the defect signal, to the regulating input of the filter (5) for defining the transfer characteristic of the filter;
- application of the output signal of the filter to the signal input of a regulating amplifier (6)
- application of the output signal of the regulating amplifier to an actuator and/or a control element (3) for the purpose of correcting the reduced image quality;
- iterative calibration of the transfer characteristic, in such a way that the reduction of the imaging quality is greatly reduced or essentially compensated for, by means of the following steps:
 - comparison of the corrected image with the real structure of the reference object
 - alteration of the transfer characteristic of the filter in such a way that the corrected

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- image approximates to the real structure of the reference object
- storage of data for generating the determined transfer characteristic of the filter for the image mode.
28. Method according to Claim 26, characterized in that, in the image mode, a sample is acquired by scanning, the transfer characteristic of the filter of the apparatus that has been determined in the calibration mode being fixedly prescribed, and the output signal of the digital filter, after passing through a regulating amplifier (6), is assigned to the actuator and/or the control element (3), with the result that image defects are greatly reduced or essentially compensated for even in the event of a change in the ambient influences.
29. Method according to Claim 22, characterized in that
- ambient influences which impair the imaging are detected by means of a sensor (3), which is arranged outside the apparatus and drives the signal input of a digital filter (5) with a first signal,
 - an image acquisition device feeds an image processing device (2), in which an image analysis is carried out and a signal dependent on the analysis is applied as the second signal to the calibration input of the filter,
 - the output of the filter is applied via a regulating amplifier (6) to an actuator and/or a control element (3) of the apparatus, which has an effect on the image, the image degradation thereby being greatly reduced or essentially compensated for.
30. Method according to Claim 29, characterized in that

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- the object to be imaged is scanned by the image acquisition device,
 - the image analysis comprises the recursive determination of the displacement of the line centroids of successive image lines within the whole image, and
 - the second signal is calculated from this temporal displacement.

31. Method according to Claim 29,
10 characterized in that

- the image analysis comprises the recursive determination of the displacement of the image centroid of successive images, and
- the second signal is calculated from this temporal displacement.

32. Method according to *Claim 30*,
characterized in that
essentially the cross-correlation of the first signal
with the second signal is carried out in the filter (5)
20 and, consequently, the actuator or the control element
(3) is fed with a drive signal which is dependent on
the cross-correlation between the first signal and
second signal.

33. Method according to *Claim 21*,
25 characterized in that

- an image acquisition device feeds an image processing device (2),
- an image analysis is carried out in the image processing device, and
- a signal dependent on the image analysis is applied as the first signal to the signal input of the filter, and
- a signal dependent on the image analysis is applied as the second signal to the calibration input of the filter,

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- 5 - the output of the filter (5) is applied via a regulating amplifier (6) to at least one actuator and/or one control element (3) of the apparatus, which has an effect on the imaging, the imaging degradation thereby being greatly reduced or essentially compensated for.
- 10 34. Method according to Claim 33, characterized in that the image analysis comprises the recursive determination of the displacement of the line centroids of successive image lines within the whole image or the recursive determination of the displacement of the image centroid of successive images.
- 15 35. Method according to ^{Claim 33} one of the preceding method claims,
- 20 characterized in that the image degradation is essentially compensated for by means of actuators and/or control elements acting in two mutually orthogonal directions.
- 25 36. Apparatus for compensating for ambient influences in imaging and/or raster-mode scanning apparatuses that may degrade the imaging, comprising:
- 25 - a calibratable digital electrical filter (5);
- 30 - a regulating amplifier (6) which is electrically connected downstream of the filter,
- 35 - an actuator and/or control element (3) driven by the regulating amplifier,
- characterized in that a first signal dependent on the ambient influences can be passed via the signal input of the filter directly through the latter, and a second signal is applied to the calibration input of the filter, and the driven actuator and/or the driven control element (3) has an effect on the image,

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whereby, in the calibrated state of the filter, the image degradation is greatly reduced or essentially compensated for.

37. Apparatus according to Claim 36,
5 characterized in that
the apparatus comprises at least one sensor (4) for
detecting at least one physical quantity outside the
apparatus, this sensor outputting the first signal
which is dependent on the ambient influences at the
10 location of the sensor.

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